Juvenile Salmonids in the Rivers of Caithness:

2015 Electric-fishing Survey.

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December, 2015.

Corrichoich, Berriedale Water.

Caithness District Salmon Fishery Board

Introduction

This report documents an electric-fishing survey of juvenile salmonids carried out by Caithness District Salmon Fishery Board in September, 2015. The aim was to build on the findings of previous surveys in 2013 and 2014 in order to provide a rigorous assessment of the current status of salmonid populations in Caithness. Most of the sites surveyed in 2013 and 2014 were repeated and three new sites were added at Inshag and Tacher (River Thurso) and Acharole (Wick River).

Methods

Site details

A total of 24 locations in the six major rivers of Caithness - Forss, Thurso, Wick, Dunbeath, Berriedale and Langwell - and a single location in the smaller, Wester catchment were surveyed (Figure 1).

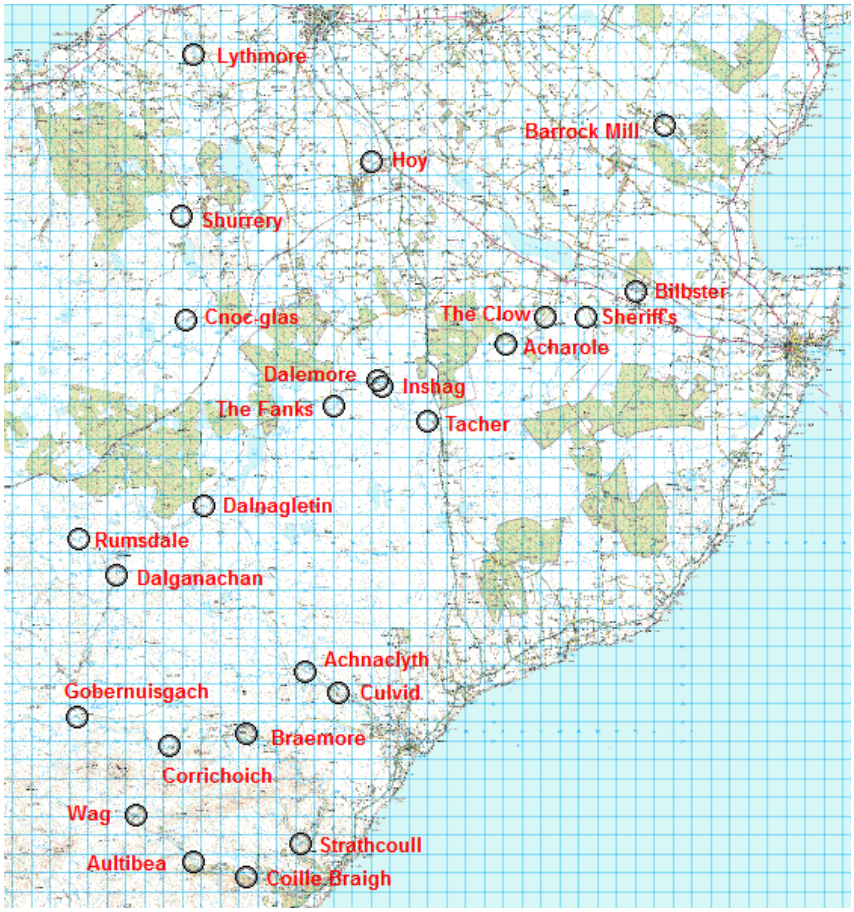

Figure 1. Map of 2015 electric-fishing survey sites.

Photographic records and bank measurements obtained in previous surveys were used to position the upper and lower stop-nets that defined each survey site. The sites repeated in 2015 therefore exactly replicated those of 2013 and 2014.

All the fish captured were the result only of natural spawning, with the exceptions of the two sites on the Dunbeath Water (Culvid and Achnaclyth) which, as previously, had been trickle-stocked with fry earlier in the year.

Table 1 shows the 2015 survey sites, identified by name and Ordnance Survey co-ordinates, and the date on which they were fished. Wetted areas derived from site dimensions (see below) are given and these were used to calculate fish densities from capture numbers.

River	**Site name**	**O.S.**	**Alt** (m)	**Date**	**Temp** (C)	**Conductivity** (µS. cm)	**Wetted area (m^2)**
Forss	Cnoc-glas	ND 042 523	110	3/9/15	12	95	193
	Shurrery	ND 039 578	89	3/9/15	13	98	90
	Lythmore	ND 047 663	24	12/9/15	14	184	184
Thurso	Rumsdale	NC 988 408	159	3/9/15	11	77	182
	Dalganachan	ND 006 391	147	8/9/15	13	77	149
	Dalnagleton	ND 052 424	124	3/9/15	13	81	265
	The Fanks	ND 120 478	91	31/8/15	15	81	141
	Tacher	ND 171 469	80	18/9/15	13	212	131
	Inshag	ND 146 488	68	18/9/15	12	210	111
	Dalemore	ND 144 491	70	31/8/15	14	82	269
	Hoy	ND 141 607	20	19/9/15	12	132	114
Wester	Barrock Mill	ND 296 626	11	4/9/15	13	228	173
Wick	Acharole	ND 212 510	56	29/8/15	14	244	105
	The Clow	ND 233 524	35	30/8/15	17	248	160
	Sheriff's	ND 255 525	33	12/9/15	13	203	170
	Bilbster	ND 281 538	9	19/9/15	13	347	387
Dunbeath	Achnaclyth	ND 105 337	120	7/9/15	12	88	129
	Culvid	ND 123 325	97	7/9/15	15	84	215
Berriedale	Gobernuisgach	NC 984 312	250	13/9/15	13	81	131
	Corrichoich	ND 034 297	200	9/9/15	15	99	134
	Braemore	ND 074 304	156	9/9/15	12	91	179
	Strathcoull	ND 103 245	38	11/9/15	12	114	116
Langwell	Wag	ND 016 260	188	10/9/15	11	122	212
	Aultibea	ND 046 236	125	10/9/15	15	122	241
	Coille Braigh	ND 074 228	93	11/9/15	14	135	171

Table 1. Electric-fishing survey sites (2015).

Electric-fishing

The electric-fishing methods used were generally those described in the Scottish Fisheries Coordination Centre (SFCC) protocol[1] and were identical to those previously used by the Board. In short, three-pass depletion fishing was carried out using a portable Honda generator to supply power to an Electracatch WF7 control box. The three fishings were carried out over a period of about three hours and the fish captured on each electric fishing pass were recorded and documented separately. The presence of non-salmonid species was recorded.

Trout and salmon were distinguished by inspection. Scale samples were obtained from parr for age determination. Scales were also obtained from fry when these were sufficiently large to place visual classification in doubt. Based on scale reading, the few fry included among the fish from which scales were sampled were subsequently assigned to the correct age group.

On completion of the site survey all the fish were returned to the stream where they had been obtained.

Data analyses

In order to compensate for variation in the size of the survey sites, the number of fish at each site was expressed as a density value based on the survey site's wetted area. In past surveys, the wetted area of each site was measured when electric fishing was carried out. However, in 2015 a separate study was carried out to establish standard values for site area. This was considered necessary because, although the length of each survey site is fixed by the position of the stop-nets and therefore constant, the wetted width varies according to stream height on the day and the wetted area varies in the same way. This lack of standardisation hinders comparison of density values between sites or between survey years.

In order to resolve the difficulty a survey of the dimensions of electric-fishing sites was carried out in October, 2015 on dates when basal stream height was sufficient to fill the normal stream channel. These new standard values will be fully documented in a separate report to the Board. The new values have been used to calculate fish density for 2015.

Fish density values specified in previous survey reports have been refined by recalculating them using the new standard values for wetted area in order to facilitate comparisons. As a consequence of recalculation, many of the density values and some of the site categorisations specified in the 2013 and 2014 reports have been revised – usually downwards. Downwards revision is the norm because electric fishing is carried out at times of low water and the site measurements of 2013 and 2014 were made under these

[1] http://www.scotland.gov.uk/Resource/Doc/295194/0096725.pdf

conditions. The definitive site areas of 2015 were obtained under standard conditions when the stream channel was fully wetted. The values for site area obtained in 2015 therefore tended to be greater than those obtained in previous years. As a consequence, the revised fish density values for 2013 and 2014 tend to be lower than those originally specified in previous reports.

At each site the number of fish captured was used to calculate observed density per unit wetted area of stream. Values for observed density were separately calculated for fry and for parr. These values were evaluated by comparison with the analysis of Scottish electric-fishing data carried out by Godfrey (2005) using SFCC data. In particular, Table 26d of Godfrey's report provides a basis for comparison based on quintile values for observed density as calculated from capture numbers for single-pass electric-fishing - or for the first pass of 3-pass fishing as in the present case. Table 4 of the current report presents an extract of these data for rivers in the North region greater than 6m in width. Godfrey also proposes a classification scheme as per Table 22 of the 2005 report and this has been modified, expanded and colour-coded as per Table 4.

Additionally, for each site, Zippin corrections were applied to the three-pass depletion counts to obtain estimates of the true total number for fry and parr. Values were computed using the program *Removal Sampling II* [2]. Estimates of true total number support comparisons among sites by compensating for variation in capture efficiency during electric-fishing. Estimated true total number was used to calculate true density per unit wetted area in order to compare sites and years.

Results

Trout and other species

Table 2 shows that trout fry were present at substantial density only at the Cnoc-glas site and were otherwise absent or infrequent. Trout parr were more widespread, being present at 20 of the 25 sites although only at low density.

Eels were present at 20 of the survey sites. Otherwise only stickleback (six sites) and brook lamprey (three sites) were identified.

[2] http://www.pisces-conservation.com/

River	Site name	Observed density of trout ($n.m^{-2}$)		
		Fry	Parr	Other species
Forss	Cnoc-glas	0.23	0.01	-
	Shurrery	0.01	-	eel
	Lythmore	0.02	0.01	eel
Thurso	Rumsdale	0.03	0.06	eel
	Dalganachan	0.01	0.03	eel
	Dalnagleton	-	-	stickleback
	The Fanks	-	0.01	eel
	Tacher	0.05	0.04	eel
	Inshag	0.02	0.05	eel
	Dalemore	-	0.01	eel
	Hoy	-	0.01	eel, stickleback
Wester	Barrock Mill	0.10	+	eel, stickleback, b. lamprey
Wick	Acharole	0.13	-	eel, stickleback
	The Clow	0.01	0.01	eel, b. lamprey
	Sheriff's	-	0.05	eel, stickleback, b. lamprey
	Bilbster	+	-	eel, stickleback
Dunbeath	Achnaclyth	-	0.04	eel
	Culvid	-	-	eel
Berriedale	Gobernuisgach	0.03	0.11	-
	Corrichoich	-	0.07	-
	Braemore	-	0.01	-
	Strathcoull	-	0.03	eel
Langwell	Wag	-	0.06	eel
	Aultibea	0.01	0.02	eel
	Coille Braigh	0.01	0.08	eel

Table 2. Presence of trout and non-salmonid species.

Salmon

Table 2 shows the primary electric fishing data for salmon fry and parr, being the number of each class captured on each of the three electric fishing passes.

River	Site name	Fry			Parr		
		1st pass	2nd pass	3rd pass	1st pass	2nd pass	3rd pass
Forss	Cnoc-glas	81	60	21	20	6	2
	Shurrery	116	33	6	67	10	2
	Lythmore	126	32	3	86	21	10
Thurso	Rumsdale	110	43	10	39	11	1
	Dalganachan	43	21	18	20	5	2
	Dalnagleton	109	46	32	1	0	0
	The Fanks	276	176	79	24	13	4
	Tacher	188	58	19	16	6	1
	Inshag	66	17	10	24	7	1
	Dalemore	546	206	90	22	20	6
	Hoy	152	31	7	51	5	1
Wester	Barrock Mill	8	3	2	5	1	0
Wick	Acharole	106	32	17	9	4	1
	The Clow	168	56	13	99	14	3
	Sheriff's	253	114	45	53	26	7
	Bilbster	149	47	19	27	16	4
Dunbeath	Achnaclyth	54	17	6	41	15	4
	Culvid	143	29	12	64	6	3
Berriedale	Gobernuisgach	11	4	2	13	3	0
	Corrichoich	37	20	3	16	8	1
	Braemore	64	21	4	53	13	1
	Strathcoull	23	12	3	34	11	5
Langwell	Wag	4	1	1	24	5	1
	Aultibea	23	4	2	47	13	2
	Coille Braigh	17	10	1	21	11	5

Table 3. Numbers of salmon fry and parr captured at each site for each pass of 3-pass electric-fishing.

Godfrey's procedure (see above) considers only single-pass fishing and, in order to match this structure, comparisons were made of densities observed on the first electric-fishing pass of the 3-pass fishing used in the present survey.

Six categories for density were defined using the critical quintile values identified by Godfrey for salmon fry or parr (Table 4). Sites were graded and colour-coded as excellent (dark blue), very good (light blue), good (green), average (yellow), low (orange) or poor (red).

	Critical percentile values for density ($n.m^{-2}$) and colour codings					
	< 20th	20th - 40th	40th - 60th	60th - 80th	80th -100th	> 100th
Fry	0.05	0.13	0.28	0.33	0.67	
Parr	0.04	0.07	0.13	0.19	0.28	

Table 4. Critical percentile values for classification of observed density ($n.m^{-2}$) of salmon fry or parr based on single-pass fishing (Godfrey, 2005).

Table 5 provides an evaluation of salmon fry and parr densities in 2015 for all the survey sites, using the colour codings given in Table 4. For fry, 18 of the 25 sites were categorised as "good" or better; the corresponding figure for parr was 13.

River	Site name	Salmon	
		fry	parr
Forss	Cnoc-glas		
	Shurrery		
	Lythmore		
Thurso	Rumsdale		
	Dalganachan		
	Dalnagleton		
	The Fanks		
	Tacher		
	Inshag		
	Dalemore		
	Hoy		
Wester	Barrock Mill		
Wick	Acharole		
	The Clow		
	Sheriff's		
	Bilbster		
Dunbeath	Achnaclyth		
	Culvid		
Berriedale	Gobernuisgach		
	Corrichoich		
	Braemore		
	Strathcoull		
Langwell	Wag		
	Aultibea		
	Coille Braigh		

Table 5. Semi-quantitative evaluation of survey sites for 2015 based on comparison with data presented by Godfrey (2005).

Site	Salmon					
	Fry				Parr	
	2013	2014	2015		2013	2014	2015
Cnoc-glas							
Shurrery							
Lythmore							
Rumsdale							
Dalganachan							
Dalnagleton							
The Fanks							
Smerrary							
Tacher							
Inshag							
Dalemore							
Hoy							
Barrock Mill							
Acharole							
The Clow							
Sheriff's							
Bilbster							
Achnaclyth							
Culvid							
Gobernuisgach							
Corrichoich							
Braemore							
Strathcoull							
Wag							
Aultibea							
Coille Braigh							

Table 6. Comparisons of fry and parr densities at survey sites for 2013, 2014 and 2015. Colour codings as per Table 5.

In Table 6, the site categorisations for 2015 have been compared with the values for 2013 and 2014. As above, the 2013 and 2014 values have been re-calculated using the new standard values for site area in order to aid comparison between years. As a consequence of the re-calculations, some of the categorisations now differ from those given in the 2013 and 2014 reports for the reasons given above. It is noteworthy that a relatively large proportion of the sites are rated "excellent" for parr in 2015.

The availability of data for three years makes it possible to begin to identify emergent patterns of difference between sites. For example, the sites at Shurrery and Lythmore are consistenty excellent for both fry and parr whereas the site at Barrock Mill is consistently poor for both. Dalnagleton and Dalemore consistently support high densities of fry but only moderate densities of parr. Fry densities at Aultibea and Coille Braigh are highly variable

although parr densities are more consistent. At Dalemore, fry densities are consistent high but parr densities are rather variable.

Table 7 shows the observed densities of salmon fry and parr derived from 3-pass fishing and a breakdown of the captured parr by age-class. No parr older than 2+ were detected.

River	Site name	Observed Density (n.m^{-2}) and year of hatch			
		0+ fry (2015)	1+ parr (2014)	2+ parr (2013)	All parr
Forss	Cnoc-glas	0.84	0.14	0.01	0.15
	Shurrery	1.76	0.88	0.04	0.93
	Lythmore	0.88	0.64	0.02	0.66
Thurso	Rumsdale	0.90	0.28	0.02	0.30
	Dalganachan	0.55	0.18	0.04	0.22
	Dalnagleton	0.71	+	-	+
	The Fanks	3.77	0.29	0.01	0.30
	Tacher	2.02	0.18	0.01	0.18
	Inshag	0.84	0.29	-	0.29
	Dalemore	3.13	0.18	0.01	0.19
	Hoy	1.67	0.50	0.02	0.52
Wester	Barrock Mill	0.08	0.03	-	0.03
Wick	Acharole	1.48	0.13	-	0.13
	The Clow	1.48	0.73	-	0.73
	Sheriff's	2.42	0.51	0.01	0.51
	Bilbster	0.56	0.12	-	0.12
Dunbeath	Achnaclyth	0.60	0.47	0.06	0.53
	Culvid	0.86	0.34	0.06	0.40
Berriedale	Gobernuisgach	0.13	0.11	0.02	0.12
	Corrichoich	0.45	0.19	0.09	0.28
	Braemore	0.50	0.37	0.04	0.42
	Strathcoull	0.33	0.43	0.03	0.46
Langwell	Wag	0.03	0.14	0.02	0.16
	Aultibea	0.12	0.23	0.03	0.26
	Coille Braigh	0.16	0.19	0.02	0.22

Table 7. Observed density of salmon fry and parr from 3-pass fishing.

Observed density values for fry and parr were transformed by Zippin correction to values for estimated true density - the most accurate values than can be derived from the primary data set. The values are shown in Table 8.

River	Site name	Estimated true density ($n.m^{-2}$)	
		Fry	All Parr
Forss	Cnoc-glas	1.02	0.15
	Shurrery	1.76	0.88
	Lythmore	0.88	0.65
Thurso	Rumsdale	0.93	0.29
	Dalganachan	0.73	0.19
	Dalnagleton	0.82	0.00
	The Fanks	4.53	0.32
	Tacher	2.09	0.18
	Inshag	0.87	0.29
	Dalemore	3.34	0.23
	Hoy	1.68	0.50
Wester	Barrock Mill	0.09	0.03
Wick	Acharole	1.55	0.14
	The Clow	1.53	0.73
	Sheriff's	2.63	0.54
	Bilbster	0.58	0.13
Dunbeath	Achnaclyth	0.62	0.48
	Culvid	0.87	0.34
Berriedale	Gobernuisgach	0.14	0.12
	Corrichoich	0.47	0.19
	Braemore	0.51	0.38
	Strathcoull	0.35	0.46
Langwell	Wag	0.03	0.14
	Aultibea	0.12	0.26
	Coille Braigh	0.18	0.25

Table 8. Estimated true density of salmon fry and parr.

All the colour-coded comparisons made so far have used the density of fish observed only on the first pass of the 3-pass electric fishing protocol deployed – as per Godfrey's procedure for classifying sites. Tables 9 and 10 compare observed densities from 1-pass fishing with estimated true densities derived from 3-pass fishing.

Site name	Estimated true density of fry (n.m^{-2})	Colour code
The Fanks	4.53	
Dalemore	3.34	
Sheriff's	2.63	
Tacher	2.09	
Shurrery	1.76	
Hoy	1.68	
Acharole	1.55	
The Clow	1.53	
Cnoc-glas	1.02	
Rumsdale	0.93	
Lythmore	0.88	
Inshag	0.87	
Culvid	0.87	
Dalnagleton	0.82	
Dalganachan	0.73	
Achnaclyth	0.62	
Bilbster	0.58	
Braemore	0.51	
Corrichoich	0.47	
Strathcoull	0.35	
Coille Braigh	0.18	
Gobernuisgach	0.14	
Aultibea	0.12	
Barrock Mill	0.09	
Wag	0.03	

Table 9. Survey sites ranked according to estimated true density of fry derived fom 3-pass fishing. The colour-coded site ratings are repeated from Table 6 and are based only on 1st pass fishing, as per Godfrey's procedure.

A high measure of overall coherence is evident between ratings based on the two measures of fry abundance.

Site name	Estimated true density of parr (n.m^{-2})	Colour code
Shurrery	0.88	
The Clow	0.73	
Lythmore	0.65	
Sheriff's	0.54	
Hoy	0.50	
Achnaclyth	0.48	
Strathcoull	0.46	
Braemore	0.38	
Culvid	0.34	
The Fanks	0.32	
Rumsdale	0.29	
Inshag	0.29	
Aultibea	0.26	
Coille Braigh	0.25	
Dalemore	0.23	
Corrichoich	0.19	
Dalganachan	0.19	
Tacher	0.18	
Cnoc-glas	0.15	
Wag	0.14	
Acharole	0.14	
Bilbster	0.13	
Gobernuisgach	0.12	
Barrock Mill	0.03	
Dalnagleton	+	

Table 10. Survey sites ranked according to estimated true density of parr derived from 3-pass fishing. Colour-coded site ratings based only on 1st pass fishing, as per Godfrey's procedure, are repeated from Table 6.

Table 10 repeats these comparisons for parr. Again, there is a high level of overall coherence between ratings based on 1st pass or 3-pass electric fishing.

For fry, the median value for estimated true density in 2015 was 0.87/ m^{-2} across all survey sites. The corresponding (re-calculated) values were 0.68/ m^{-2} in 2013 and 1.17/ m^{-2} in 2014. For parr, the median value across all survey sites in 2015 was 0.23/ m^{-2} compared with (re-calculated) values of 0.21/ m^{-2} and 0.23 / m^{-2} for 2013 and 2014, respectively.

Figures 2 – 5 show how the density values for fry or parr were distributed in 2015 and how this compared with 2013 and 2014.

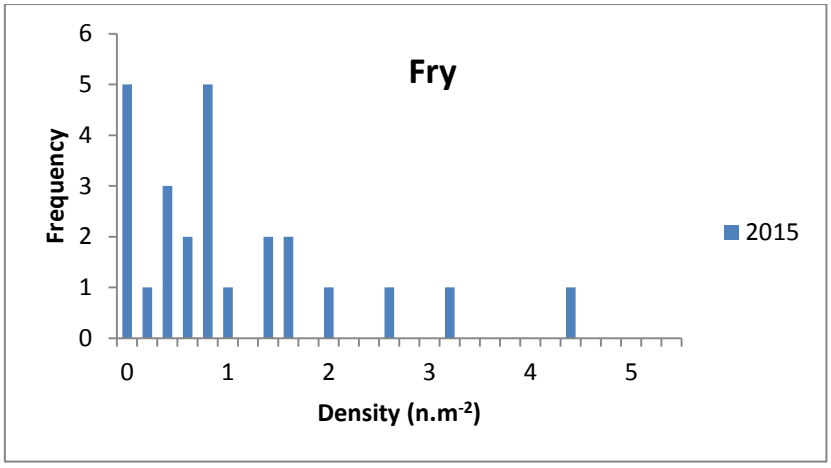

Figure 2. Frequency distribution of site density values for fry in 2015.

Figure 2 shows a wide range of values for fry in 2015, including the high value of 4.53.m-^{2} (The Fanks, River Thurso) counter-balanced by five sites in the 0 – 0.2.m^{-2} density range (Coille Braigh, Aultibea and Wag, all Langwell River, Gobernuisgach, Berriedale River, and Barrock Mill, River Wester).

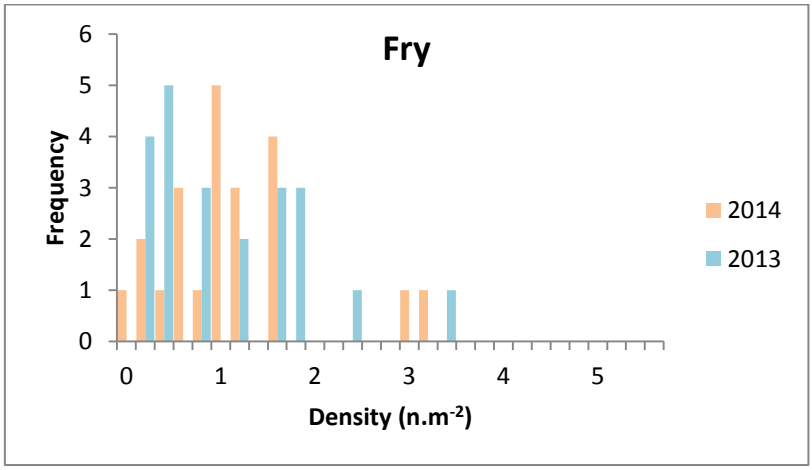

Figure 3. Frequency distribution of site density values for fry in 2013 and 2014.

Figure 3 confirms the exceptionally wide spread of the 2015 values for fry density relative to those of 2013 and 2014 and, in particular, emphasises the unusual number of low density fry sites in 2015.

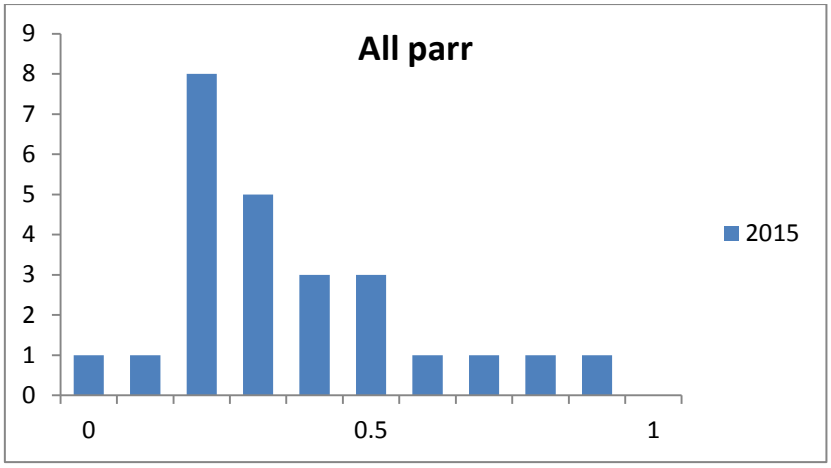

Figure 4. Frequency distribution of site density values for parr in 2015.

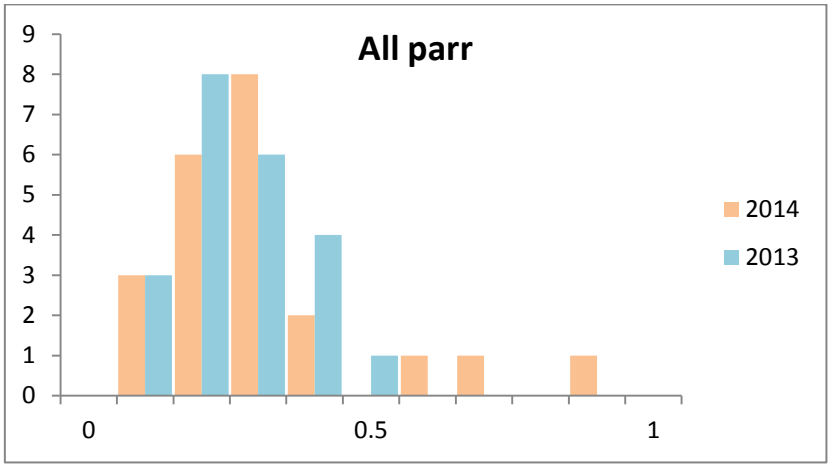

Figure 5. Frequency distribution of site density values for parr in 2013 and 2014.

Figure 4 shows that the frequency distribution of parr in 2015 was more evenly spread across the range of observed values than was the case in either 2013 or 2014. This probably reflects the similarly even distribution of fry evident in 2014 (Figure 3).

The data described in this report will be the subject of a more detailed analysis of the combined 2013-2015 data sets and a further report will be prepared for the Board.

Acknowledgements. The excellent contributions made by the members of the field team are acknowledged. Cammie Chapman, Geordie Doull Jnr, Neil Groat, Jamie McCarthy, Pat Quinn and Dougie Reid all participated at various times. Eddie McCarthy provided logistical support. Iain McLaren read the scales.